

IEC/PAS 62276

Edition 1.0
2001-08

**Single crystal wafers applied
for surface acoustic wave device –
Specification and measuring method**

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PUBLICLY AVAILABLE SPECIFICATION



INTERNATIONAL
ELECTROTECHNICAL
COMMISSION



Reference number
IEC/PAS 62276

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電子情報通信学会規格

**The Institute of Electronics, Information and Communication
Engineers Standard**

**Single crystal wafers applied for surface acoustic wave
device 0**

- Specification and Measuring method -

弾性表面波デバイス用単結晶ウェーハ
—規格と測定法—

IEICE/Std - 0002

2001 年 4月

April, 2001

(社)電子情報通信学会

**The Institute of Electronics, Information and
Communication Engineers**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SINGLE CRYSTAL WAFERS APPLIED
FOR SURFACE ACOUSTIC WAVE DEVICE –
SPECIFICATION AND MEASURING METHOD**

FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public and established in an organization operating under given procedures.

IEC-PAS 62276 was submitted by the Japanese Institute of Electronics, Information and Communication Engineers and has been processed by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P members of the committee concerned as indicated in the following document:

Draft PAS	Report on voting
49/504/PAS	49/513/RVD

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming the PAS into an International Standard.

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FOREWORD

Although the mobile communication is spreading rapidly with a global scale in recent years, the surface acoustic wave device is used, to the cellular phone that is used for these widely. Wafers of the various single crystal piezoelectricity materials are used for those devices. However, those standard is carried out individually between a manufacturer and user, that is actual situation.

As the demands of single crystal wafers are increasing, it is indispensable to standardize them such as the terms and definitions, test conditions, measurement methods of materials, and guide the use.

International Electrotechnical Commission located in Geneva is actively working for the international standardization in the electrotechnical field. Among many Technical Committees (TCs) in IEC, TC 49 is working on the Piezoelectric and Dielectric Devices for Frequency Control and Selection. TC 49 has ten Working Groups (WGs), and the Working Group 5 (WG 5) is working for the preparation and deliberation of the IEC standard on the piezoelectric single crystal.

The piezoelectric and dielectric devices for frequency control and selection in the Standard Committee of the Institute of Electronics, Information and Communication Engineers have gotten active as the interior deliberation party of IEC/TC 49. On the other hand, QIAJ (Quartz Industry Association of Japan) is the industry meeting that was organized with the maker of a crystal unit and the activity corresponding to TC 49/WG 5 is done by the material committee which belongs QIAJ. This document was issued by the material committee of QIAJ, under cooperation with the 10th work sectional meeting (WG 10) of TC 49.

When the Japanese National Committee for IEC/TC 49 proposed this documents as a new work item proposal (49/428/NP), however, was not approved (49/RVN/440), because only two countries; Germany and Japan, nominated experts to participate this project. According to the IEC rule for the New Work Items Proposal, it is required to start a new project that more than four P-member countries should nominate the name of experts and this proposal failed. But, the Japanese National Committee for IEC/TC 49 decided to continue the work to draft this standard, even though it was not approved, because we believed that this should be a very fundamental, useful and mandatory documents. Therefore, Technical Committee of QIAJ cooperated to make out this work and the draft was reviewed at the TC 49 Nara meeting, April, 2000 and recommended as a PAS document (49/RVN/474). Finally, this document has been completed

published as a standard of the Institute of Electronics, Informaion and Communication Engineers and a technical standard of QIAJ.

This standard is a fruit of collecting wisdom in the field of advanced technology in Japan and it is open for public as the Standard of the Institute of Electronics, Informaion and Communication Engineers. And it is expected that this standard will contribute to the development of technology in this fast growing field. This standard will be submitted to the IEC in the track of IEC PAS (Publicly Available Specification) for international circulation.

Finally, I would like to express my sincere appreciation to Mr. Kunihiro Nagai, Chairman, all members of the 10th work sectional meeting (WG 10) of the Japanese National Committee for IEC/TC 49 and Technical Committee of QIAJ, for their efforts develop this standard.

Mikio Takagi
Chairman

The Japanese National Committee for IEC/TC 49
in the Standard Committee of the Institute of
Electronics, Information and Communication Engineers.

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**Contributors to "Single crystal wafers applied for surface acoustic wave device
-Specification and Measuring method- "**

Chief	Mr. Kunihiko Nagai (Toyo Communication Equipment)
Member	Mr. Kazushi Kamiyama (Kyocera)
Member	Mr. Masakazu Kurashige (Kinseki)
Member	Mr. Masami Mochizuki (Koike)
Member	Mr. Hajime Shimizu (Koto Crystal)
Member	Mr. Toshihiko Ryuou (Shinetsu Kagaku kogyo)
Member	Mr. Masayoshi Matsui (Sumitomo Metal Mining)
Member	Mr. Shinichi Shikada (Sumitomo Denki Kogyo)
Member	Mr. Susumu Maeda (Daishinku)
Member	Mr. Katsuma Meroishi (Tokyo Denpa)
Member	Dr. Sadao Matsumura (Toshiba)
Member	Dr. Junichi Kushibiki (Tohoku University)
Member	Dr. Masaaki Ono (Fujitsu Media Device)
Member	Mr. Junji Takahashi (Nihon Dempa Kogyo)
Member	Mr. Yutaka Mikawa (Fine Crystal)
Member	Heiji Takashima (Meidensha)
Member	Itetaka Sahashi (Yamaju Ceramics)

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Single crystal wafers applied for surface acoustic wave device - Specification and measuring method

Introduction

A number of piezoelectric materials has become to use for surface acoustic wave (SAW) filters and resonators according to increasing wide electrical application and production demand. Until now, specifications for wafers were subjected to agreement between user and supplier. By these circumstances, IEC meeting in 1996 held at Rotterdam, Holland had announced to make proposals about new wafer standardization. This specification is respond to the standardization request in piezoelectric single crystal wafers for surface acoustic wave devices.

Section 1: Specification for single crystal wafer

1 Scope

This document applies to single crystal wafers intended for manufacturing substrates made of synthetic quartz crystal, lithium niobate, lithium tantalate, lithium tetraborate crystals for surface acoustic wave (SAW) filters and resonators.

2 Reference documents

IEC 60758:1993 Synthetic quartz crystal – Specifications and guide to the use

IEC 60862-1:1989 Surface acoustic wave (SAW) filters. Part 1: General information, standard values and test conditions chapter I : General information and standard value –chapter II : Test conditions

IEC 60862-2:1991 Surface acoustic wave (SAW) filters-Part 2:Guide to the use of surface acoustic wave filters (chapter III)

IEC 60862-3:1986 Surface acoustic wave (SAW) filters. Part 3 : Standard outlines (Chapter IV)

IEC 61019-1-1:1990 Surface acoustic wave (SAW) resonators-Part 1: General information, standard values and test conditions-Section1 General information and standard values

IEC 61019-1-2:1993 Surface acoustic wave (SAW) resonators-Part 1: General information, standard values and test conditions-Section2:Test conditions

IEC 61019-2:1995 Surface acoustic wave (SAW) resonators-Part 2: Guide to the use

IEC 61019-3:1991 Surface acoustic wave (SAW) resonators-Part 3: Standard outline and lead connections.

IEC 60410 Sampling plans and procedures inspection by attributes

3 Terms and definitions

3.1 Single crystals for SAW wafer

3.1.1 As-grown synthetic quartz crystal: Right handed or left handed single crystal quartz grown hydrothermally. As-grown refers to the state of processing and indicates a state prior to mechanical fabrication.

3.1.2 Lithium niobate: Single crystals described by chemical formula to LiNbO_3 grown by Czochralski method (crystal pulling method) or other growing method.

3.1.3 Lithium tantalate: Single crystals described by chemical formula to LiTaO_3 grown by Czochralski method (crystal pulling method) or other growing method.

3.1.4 Lithium tetraborate: Single crystals described by chemical formula to $\text{Li}_2\text{B}_4\text{O}_7$ grown by Czochralski method (crystal pulling method), vertical Bridgeman method or other growing method.

3.2 Manufacturing lot: Lot consists of one LN, LT or LBO crystal or one synthetic quartz crystal growth batch.

3.3 Terms and definition related synthetic quartz

3.3.1 Seed: A rectangular parallelepiped crystal plates or bar to be used as a nucleus for crystal growth.

3.3.2 Infrared absorption coefficient α -value: Measured absorption at specific infrared wavenumber by means of defect structures as OH-bond in crystal lattice.

$$\alpha = \frac{1}{t} \log \frac{T_1}{T_2}$$

α : Infrared absorption coefficient

t: Thickness of Y-cut sample in centimeter

T1: Percent transmission at wavenumber of 3800 or 3979 cm^{-1}

T2: Percent transmission at wavenumber of 3410, 3500 or 3585 cm^{-1}

3.3.3 Inclusions: Any foreign materials within a crystal, visible by examination of scattered light from a bright source.

3.3.4 Seed veil: The array of inclusions or voids on the surface of the seed upon which a crystal has been grown.

3.3.5 Etch channel: An etch channel is a roughly cylindrical void that is present along dislocation line after etching a quartz crystal.

3.3.6 Pinhole in seed: Pipe-like cavity along the dislocation (or line defects) within seed created at initial duration of quartz crystal growth.

3.4 Terms and definition related LN and LT crystal

3.4.1 Lattice constant: A length of one unit cell measured by X-ray using Bond method

3.4.2 Curie temperature: Phase transition temperature between ferroelectric and paraelectric by thermal analysis or dielectric measurement

3.4.3 Single domain: In a state of same electrical polarization in ferroelectric crystal (i.e. LN and LT).